

No Reprieve: Extreme Heat at Night Contributes to Heat Wave Mortality

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It is well understood that heat can be deadly, and that climate change is bringing hotter days and higher average temperatures around the globe.¹ What is less widely known is that overnight low temperatures are rising even more rapidly than daytime highs^{2,3}—and some of heat’s toll on human health can be attributed to those hotter nights, according to the authors of a study recently published in *Environmental Health Perspectives*.⁴

“The daily minimum temperature plays a significant role in health because if the overnight temperature does not fall below a certain threshold value, people are unable to cool down and recover⁵ from the daytime heat,” the authors write. “Hot nights could impose an extra burden on the body. . . , suggesting that the daily minimum temperature can be considered a risk factor for heat-induced illness.”⁴

To learn more about mortality risks associated with hot nights, a team of researchers based in Japan, the United Kingdom, and Switzerland drew upon a huge data set of daily minimum and maximum temperatures from 1973 to 2015 for each of Japan’s 47 prefectures, which range in latitude from 45°N (roughly the same as Montreal, Canada) to 24°N (similar to Key West, Florida). They

analyzed daily mortality data for each prefecture over that 43-year period to look for associations between hot nights and death rates from a variety of causes.

The researchers found that, even when controlling for daily mean temperature, national all-cause mortality increased by 9% following “tropical nights.” These are defined as nights on which the minimum temperature stayed above 25°C (77°F), a physiology-based threshold set by the Japan Meteorological Agency, according to the authors.

Given the broad range of climates represented across Japan’s prefectures, the researchers performed a second analysis using the 95th percentile of each prefecture’s daily minimum temperature during the study period. This relative definition of hot nights accounted in part for local behavioral and physiological heat adaptation. Interestingly, this method of analysis did not change the result by much: Nationwide, they estimated an average 10% increase in all-cause mortality compared with cooler nights, independent of daytime temperature.

“There have been analyses over the years^{6–8} suggesting that hot nights in fact do contribute to excess mortality in heat waves,” says



It is not just the peak daytime temperature that matters when the weather is hot; the body’s ability to cool down at night is important too, according to the authors of the new study. “Hot nights could impose an extra burden on the body. . . , suggesting that the daily minimum temperature can be considered a risk factor for heat-induced illness,” they write.⁴ Image: © Sutichak/stock.adobe.com.

University of Washington professor Kristie Ebi, an expert in the health effects of heat. She was not involved with the study but has collaborated with some of its authors in the past.⁹ “Having the very long time series in this paper and being able to look specifically at nighttime temperatures is an important contribution to the literature,” she says. “We need to understand how hot nights, combined with hot days, affect overall excess mortality during a heat wave.”

The team reviewed 11 causes of death: cardiovascular disease, ischemic heart disease, cerebrovascular disease, cerebral hemorrhage, cerebral infarction, respiratory disease, pneumonia, chronic obstructive pulmonary disease, asthma, renal disease, and advanced age. They found that under both absolute and relative definitions of hot nights, the effect of overnight heat on health was not isolated to any particular cause of death, but was in fact strongly associated with all 11 causes reviewed.

The reported associations appeared immediately after the hot night and persisted longer than was observed in previous studies of heat-related mortality, says first author Satbyul Estella Kim, an assistant professor of health and sport sciences at Japan’s University of Tsukuba. “That longer lag was quite interesting to me,” she says. “Previous research¹⁰ showed that the mortality lag after a heat wave was two or three days. Our hot-night analysis shows that the lag is longer, around ten days to two weeks.” This finding could be specific to Japan, Kim explains, but it also makes sense that the health effects of daytime versus nighttime heat might play out differently owing to the variety of physiological, behavioral, and environmental factors involved.

The risk level due to hot nights varied by prefecture, with generally greater effects in the cooler north. The authors also found a higher mortality risk from hot nights in early summer compared to late summer in all regions, similarly indicating a critical role for behavioral and physiological adaptation.

For public health, these findings underscore the urgency of reducing exposure to hot overnight temperatures, says Patrick Kinney, a professor of urban health and sustainability at Boston University who was unaffiliated with the study but, like Ebi, has also collaborated with some of the authors in the past.⁶

“The urban heat island effect is particularly important at nighttime,” Kinney says. “Policies to reduce the heat island effect would be especially helpful, like adding more trees and green space, and using reflective building materials that don’t absorb heat, such as white roofs.”

Additionally, suggests senior author Yasushi Honda, a professor of health and sport sciences at the University of Tsukuba, public safety heat alerts could be expanded to include high overnight temperatures in addition to excessive daytime temperatures. Such warnings could encourage vulnerable residents, especially older adults, to take precautions such as operating fans or air conditioning at night and drinking more water before bed.

Nate Seltenrich covers science and the environment from the San Francisco Bay Area. His work on subjects including energy, ecology, and environmental health has appeared in a wide variety of regional, national, and international publications.

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